International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 8, 2025
https://theaspd.com/index.php

Node Evaluation In Urban Design: Current Status And Analysis Of Research Potential

Danyang Wang[1] , Nor Zalina Binti Harun[2], Nor Haslina Binti Ja`afar[3]
[1]Institute of The Malay World and Civilization, Universiti Kebangsaan Malaysia, UKM Bangi, Selangor 43600, Malaysia.
[2]Universiti Kebangsaan Malaysia, UKM Bangi, Selangor 43600, Malaysia.
[3]Department of Architecture, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, UKM Bangi, Selangor 43600, Malaysia.
[1]Kashi University , Kashgar, 844000, China.

Abstract
With the acceleration of global urbanization, urban nodes have emerged as key elements in shaping urban structures and a central theme in urban planning, transportation, and landscape design. This study aims to systematically evaluate the current state of research on urban nodes, clarify their disciplinary scope, and identify future development trends. Using bibliometric analysis of 784 publications retrieved from the Web of Science database, combined with cluster visualization through CiteSpace and descriptive as well as evaluative approaches, we provide a comprehensive overview of the field. Specifically, the study analyzes publication volume, spatial distribution, disciplinary foundations, keywords, and co-occurrence patterns to map the research landscape and highlight its evolution.The results show that urban node research spans diverse domains, including economics, ecology, urban transportation, and information technology, with increasing attention to interdisciplinary integration. While the theoretical framework has expanded, a significant gap remains between research and practical application. The focus of inquiry is gradually shifting from functional and physical construction toward human-centered design, with growing emphasis on social well-being, psychological needs, and service provision. This transformation underscores the importance of cross-disciplinary collaboration and the integration of theory with practice. Overall, the study not only synthesizes the current knowledge base but also points to emerging hotspots and challenges, offering guidance for future research that aims to support the sustainable and holistic development of urban nodes.
Keywords: *Urban Nodes; Urban Design; Citespace; Interdisciplinary Collaboration*

1.INTRODUCTION

Urban design is a crucial component in shaping our built environment, coordinating the complex relationships between spatial design, social dynamics, and environmental sustainability. As an evolving field, urban design plays a pivotal role in determining the form and characteristics of urban spaces.It includes the layout of buildings, public spaces and overall infrastructure, which determines the livability and vitality of the urban environment（Montgomery,1998）[1]. However, the field faces major challenges, mainly in terms of sustainability, functionality and adaptability, especially in the context of rapid urbanization and changing environmental issues (Ahern, 2011)[2]. As research in urban design has advanced, the study of "nodes" has garnered increasing attention and has gradually evolved into a practical research pathway. Lynch (1960)[3] defined urban nodes as significant gathering points within a city, typically located at transportation hubs, city squares, major intersections, or centers of public activity. These nodes play a crucial role in connecting and facilitating interactions within the urban structure. Bertolini (1999)[4] further posited that "nodes" can be considered strategic, highly accessible, and multifunctional areas in urban design.

The design of these nodes can enhance interaction and connectivity between different parts of the city, significantly influencing the dynamics and spatial development patterns of urban areas. Firstly, in practical urban design, the effective integration of urban nodes can further optimize urban spaces. As catalysts for sustainable transportation, economic development, and social interaction, these nodes can enhance the overall quality of urban life (Surya et al., 2020)[5]. Secondly, nodes improve urban connectivity by linking different parts of the city. They facilitate the flow of pedestrians, vehicles, and public transportation, making urban areas more accessible and navigable (Yang et al., 2023)[6]. Thirdly, nodes serve as focal points for social interaction and community engagement. They provide spaces where people can gather, interact, and participate in community activities, fostering a sense of community and belonging (Semenza & March, 2009)[7]. Finally, well-designed urban nodes contribute to the economic vitality of urban areas by creating vibrant commercial and cultural districts, thereby promoting local economic development (Della Spina, 2019)[8]. Therefore, urban nodes are crucial for enhancing urban quality of life, fostering social interaction, and promoting environmental sustainability, serving as key avenues for improving residents' living experiences and encouraging social participation (Gehl, 2010)[9].

This study conducts an in-depth exploration of node research within the field of urban design since 1979. It aims to evaluate the current state of urban nodes, analyze the methodologies employed, and highlight the research potential in this domain. By utilizing CiteSpace for visual analysis, this study maps and organizes data on the "urban nodes" research field, examining the current status, hotspots, and trends. The findings provide valuable insights and guidance for enhancing urban sustainability, revealing potential opportunities in urban studies that have yet to be fully explored.

2.DATA SOURCES AND ANALYTICAL METHODS

2.1.Data Sources

The primary data source for this study is the Web of Science (WOS) database, renowned for its comprehensive coverage of high-quality academic journals. WOS is a multidisciplinary citation indexing platform that encompasses research outputs across various fields, including the arts, humanities, social sciences, and more. This broad scope allows for a diverse and comprehensive collection of literature, making it an ideal resource for constructing a thorough literature review. To ensure the reliability and comprehensiveness of the data, a detailed search strategy was employed to identify publications related to urban nodes. The following search query was used: “(TS=(“urban” OR “space” OR “landscape” OR “transportation”)) AND TS=(node)”. To maintain readability and relevance, this study utilized the WOS Core Collection as the primary data source, focusing on research related to urban planning, design, transportation, and landscape architecture with an emphasis on urban nodes. The dataset included only articles published in English, with the search covering all years available in the WOS Core Collection to ensure comprehensive coverage of the field. After filtering out irrelevant materials such as conference abstracts, proceedings, books, trade journals, and reports, a total of 784 relevant publications were selected as the study's dataset.

2.2. Analytical Methods

To map the relevant knowledge domains of urban nodes, a comprehensive methodology is required. This study primarily utilizes bibliometric analysis and the CiteSpace visualization tool to systematically review and analyze the current research landscape, key topics, and future trends in urban node research. Bibliometric analysis, through the statistical examination of publication

volume, distribution, citation patterns, and other related data, reveals the developmental trajectory of research in a specific field (Donthu et al., 2021)[10]. By integrating bibliometrics, we analyze relevant publications, focusing on annual publication volume, thematic distribution, keywords, and the evolution of topics within this domain to highlight the progression and patterns in urban node research.

CiteSpace, a widely used tool for scientific literature visualization and analysis, facilitates the identification of research hotspots and trends by constructing knowledge maps. Through methods such as co-occurrence analysis, cluster analysis, and burst detection, CiteSpace helps determine the knowledge structure and developmental trends within related fields (Jia et al., 2021)[11]. This study employs bibliometric analysis and CiteSpace software to create knowledge maps, analyzing literature data on the basic overview, research hotspots, and thematic evolution of urban nodes, thus providing a comprehensive review of the current state and future trends in node-related research within urban environments.

3.RESEARCH TRENDS IN URBAN NODES STUDY

3.1. Data Analysis

3.1.1 Trends in Publication Volume

The statistical data from this study (Figure 1) reveal that the research on urban nodes has undergone three distinct phases: the initial development phase (1976-2009), the fluctuating development phase (2010-2019), and the rapid growth phase (2020-2024). During the period from 1976 to 2009, the number of publications on urban nodes was relatively low, with the annual number of papers hovering in the single digits. This indicates that during this period, research on urban nodes had not yet garnered widespread attention, and the foundational research was relatively weak.This phase can be regarded as the initial development stage of urban node research, where studies gradually increased in number but had yet to form a substantial body of work. Starting from 2010, there was a noticeable upward trend in the volume of publications. Although there were minor fluctuations in the number of studies during this period, the overall trend was upward, indicating that research hotspots were beginning to form and academic interest was significantly increasing. After 2020, the field entered a rapid expansion phase, with the number of publications rising sharply each year, peaking in 2023 before slightly declining but remaining at a high level. This suggests that during this period, urban node research had become a significant focus within urban studies, characterized by diversification and deepening of research topics, covering various aspects of urban nodes.

The changes in publication volume clearly show that urban node research is increasingly becoming a hot topic in the academic community. Looking ahead, as urban science research deepens and urban planning demands continue to evolve, the study of urban nodes is expected to maintain its growth trajectory.

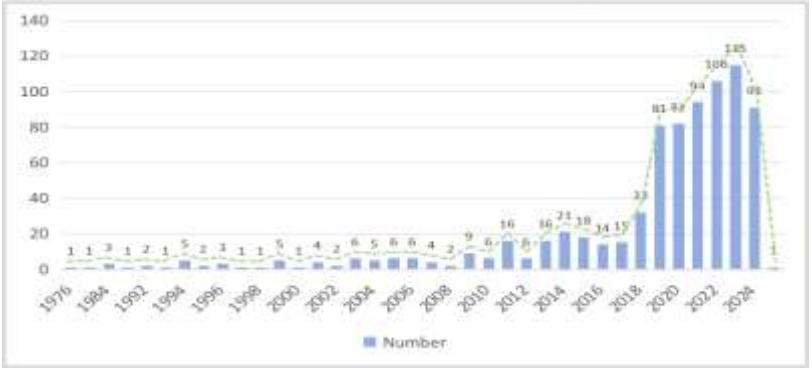


Figure 1. Statistics and Trends of Urban Node-Related Publications from 1976 to 2024 (Data as of July 18, 2024).

3.1.2 Spatial Distribution

Using CiteSpace software, an analysis of the literature on urban nodes published between 1976 and 2024 was conducted by constructing a country co-occurrence map, with the Betweenness Centrality (BC) value of each country serving as an evaluation metric. In CiteSpace, Betweenness Centrality is typically used to identify publications or researchers that play a crucial connecting role between different research groups or disciplines. Nodes with higher Betweenness Centrality usually hold a more significant position within the academic network (Freeman, 1979)[12]. Therefore, by analyzing Betweenness Centrality, it is possible to identify the countries or regions that play a central role in the field of urban node research.

Based on the established country publication co-occurrence map analysis (Figure 2), the countries with the highest number of publications on urban nodes are China and the United States. Following them are the United Kingdom, Italy, New Zealand, and Australia, which also have a relatively high volume of publications. The United States initiated research on urban nodes earlier than other countries and has produced significantly more publications. In contrast, China's research on this topic began relatively later, but it has quickly become the leading country in terms of publication volume, reflecting a rapid development trajectory in this field.

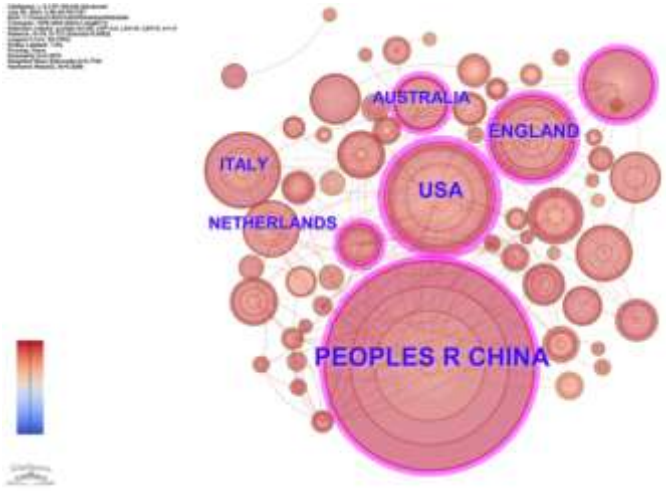


Figure 2. Co-authorship Network of National Publications from 1976 to 2024.

From the map and statistical table (Table 1), it is evident that there are significant differences in the contributions and influence of different countries in the field of urban node research. We primarily focused on countries with a Betweenness Centrality (BC) greater than 0.01 and categorized them into two groups. The first group consists of countries with a BC greater than 0.1, including the United States, Germany, China, the United Kingdom, India, and Australia. These countries dominate both in terms of the number of publications and Betweenness Centrality. China has the highest output with a total of 276 publications and a BC of 0.16, indicating its prolific research production in this field. The United States, while having 109 publications, boasts the highest BC at 0.27, highlighting its pivotal role in knowledge dissemination and academic exchange within the field.Despite having relatively fewer publications, other countries still demonstrate significant influence in the field of urban node research. For example, Germany, with fewer publications, has a BC second only to that of the United States. This indicates that Germany plays a crucial role in connecting and disseminating

research within this domain. The second group of countries includes those with a BC ranging between 0.01 and 0.1, such as Canada, France, and the Netherlands. These countries, while producing fewer publications and having lower BC values, still serve as vital connectors within their respective regions. Although their influence within the global knowledge network is weaker, their publication volume and BC values suggest that they hold a certain level of importance within regional knowledge networks. The third group of countries, with BC values between 0.0 and 0.01 (inclusive of 0.01), includes nations such as Spain, Malaysia, and Singapore. These countries exhibit varying levels of publication output and possess lower BC values, indicating limited influence in the global academic network. However, they still play a significant role within local or regional networks, although their global impact remains relatively modest.

Table 1. Statistics of Urban Node Research Publication Counts and Betweenness Centrality (BC).

Country	Frequency	BC	Year	Country	Frequency	BC	Year
United States	109	0.27	1976	Chile	5	0.04	2020
Germany	27	0.17	1994	Sweden	9	0.04	1994
China	276	0.16	2004	Switzerland	8	0.04	2011
England	56	0.14	1992	Italy	41	0.03	2014
India	25	0.12	2005	Indonesia	9	0.01	2021
Australia	34	0.11	1996	Iran	7	0.01	2019
Canada	20	0.08	2001	Japan	15	0.01	2005
France	11	0.08	1999	Malaysia	20	0.01	2015
Netherlands	36	0.08	2006	Singapore	16	0.01	1999
Czech Republic	4	0.05	2016	South Africa	12	0.01	2003
South Korea	15	0.05	2000	Spain	28	0.01	2014
Belgium	14	0.04	2006	Vietnam	2	0.01	2019

3.1.3 Distribution of Research Disciplines

Subject Categories analysis plays a critical role in scientific research, as it can reveal the interdisciplinary impact within a specific research domain (Chen, 2006)[13]. By constructing a co-occurrence map of subject categories in urban node research, it is possible to identify the primary disciplines involved in this field and their interconnections, thus providing insights into the knowledge structure and developmental trends of the area. In the map, different colors represent various subject categories, while the size of the nodes and the thickness of the connecting lines reflect the closeness of the relationships between disciplines and the volume of related literature (Figure 3).

In the map, the red area represents "Transportation," which is a core discipline in the field of urban node research, highlighting the crucial role of transportation in urban nodes, encompassing aspects such as urban transportation planning and traffic flow management (Vale, 2015)[14]. As a central discipline, "Transportation" is integrated with other subject categories like "Urban Studies," "Environmental Sciences," and "Economics" to form the comprehensive system of urban node research. Additionally, environmental disciplines such as "Environmental Sciences" (#2) and "Environmental Studies" (#8) closely follow, emphasizing the interaction between urban nodes and the environment, covering areas such as ecosystem services,

environmental protection, and sustainable development (Button, 2002) [15] . Additionally, "Computer Science, Information Systems" (#3) also holds a significant position in the map, reflecting the application of smart city technologies, information systems management, and data analysis in urban node research. This highlights the growing role of modern technology in this field (Cicirelli et al., 2017)[16]. Furthermore, the commercial sector is another key component of urban node research, encompassing disciplines such as "Economics" (#4), "Business" (#5), and "Architecture" (#10). These fields not only emphasize the role of urban nodes in fostering economic activity and commercial prosperity (Pugalis, 2009)[17] but also focus on optimizing urban resource allocation and management decision-making, underscoring the importance of management science in enhancing the functionality of urban nodes (Lu et al., 2024)[18].

The analysis of the subject category co-occurrence map in urban node research reveals a distinct multidisciplinary nature within the field. The study listed 10 core disciplines namely "Transportation," "Urban Studies," "Economics," and "Business" are closely interconnected. "Transportation" plays a pivotal role in urban node research, interacting significantly with "Management Science" and "Environmental Sciences." Meanwhile, "Urban Studies" aligns closely with the development trends in smart city technologies, whereas "Economics" and "Business" underscore the importance of urban nodes in economic and commercial activities. This multidisciplinary characteristic suggests that future urban node research should further enhance collaboration across different disciplines, integrating various research methods and technological approaches to achieve a more comprehensive understanding and optimization of the functions and roles of urban nodes.

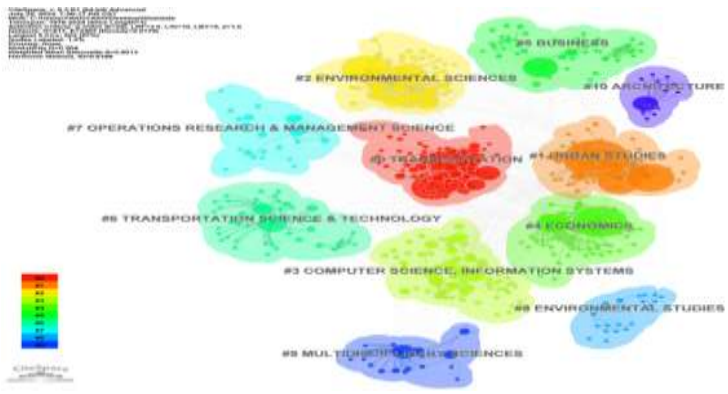


Figure 3. Subject Categories Clustering Map of Urban Nodes Research

3.2.Analysis of Research Hotspots and Frontiers

In the study of urban nodes, keyword analysis methods are widely employed to uncover research hotspots and emerging trends. These methods include keyword co-occurrence analysis, clustering analysis, timeline analysis, and burst analysis, each providing insights from different perspectives into the thematic structure and evolutionary trends of the research field.

3.2.1. Keyword Co-Occurrence Analysis

The keyword co-occurrence analysis method identifies high-frequency keywords and their co-occurrence relationships within the literature, allowing for the construction of a keyword co-occurrence network map that illustrates the connections between keywords and their significance (Cobo et al., 2011)[19]. In this study, a keyword co-occurrence map was constructed within the field of urban nodes (Figure 4). Each node in the map represents a keyword, with the size of the node reflecting the frequency of the keyword's occurrence. The map identifies a total of 535 nodes, indicating the wide range of research themes in this field. The results show that, in addition to

core search keywords such as "City" and "Urban," the research on urban nodes is primarily focused on keywords such as "land use," "accessibility," "transport," "travel," "model," and "design." These keywords highlight the key areas of focus and the developmental trends within the study of urban nodes.

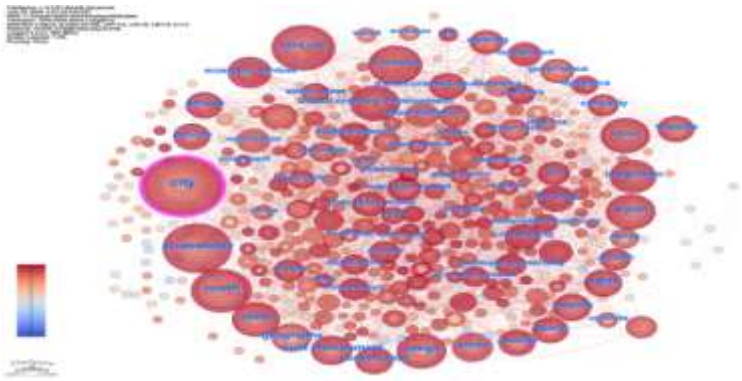


Figure 4. Literature keywords co-occurrence map.

The analysis of high-frequency keywords in the field of urban nodes using CiteSpace (Table 2) reveals the top 15 keywords, ranked according to their frequency of occurrence, along with the years they first appeared. Among these, the term "City" stands out as the most frequently mentioned keyword, indicating its central role in urban node research. Since 1994, studies related to urban themes have consistently garnered significant attention across various periods. As shown in Table 2, the core themes of urban research include "Land use," "Accessibility," "Design," "Model," and "Transport." These keywords encompass a wide range of topics, including urban infrastructure (Rahman, Ashik, & Mouli, 2022)[20], urban ecosystem services (Lu et al., 2022)[21], public transportation (Nigro, Bertolini, & Moccia, 2019)[22], urban design (Yun et al., 2019)[23], and socio-economic impacts (Debrezion, Pels, & Rietveld, 2007)[24]. This diversity reflects the broad scope and complexity of urban research themes.

By integrating the ranking of keywords based on BC (Table 3), it is possible to identify the main research directions and emerging trends within the field. These findings highlight the evolving nature of urban node research, as well as the multifaceted aspects that researchers are exploring in this domain.

Research Foundations: Transportation and Accessibility

Through the analysis of high-frequency words and betweenness centrality keywords (Tables 2 and 3), it is evident that "Accessibility" ranks highly in both categories, highlighting its close association with the concept of urban nodes. Kevin Lynch (1960) defined nodes as key points within urban spaces. Building on this, Czarnecki and Chodorowski (2021)[25] further developed the concept, proposing that nodes are grids and intersections within the urban network. Both perspectives emphasize the inseparable relationship between urban nodes and transportation. In addition to the high-frequency keyword "Accessibility," four other transportation-related keywords,"Transport," "Travel," "Mobility," and "TOD" (Transit-Oriented Development),also appear prominently in the tables.

In-depth research on relevant literature shows that in the existing urban node research, the research related to urban transportation basically covers multiple fields, including the accessibility of public transportation nodes (Lahoorpoor & Levinson., 2020)[26], the connectivity and accessibility of urban walking (Jabbari, Fonseca & Ramos., 2021)[27], the accessibility evaluation of infrastructure (COYES CHAVES et al., 2023)[28], and the accessibility of visual design in space

(Ahmed et al., 2022)[29]. These studies together constitute a systematic discussion of the relationship between urban nodes and transportation.

In urban node research, scholars argue that enhancing the accessibility of public transportation stations and their surrounding areas can foster more compact and sustainable urban development models (Papa & Bertolini, 2015)[30]. Moreover, the accessibility level of urban nodes directly influences residents' ability to access public services such as education, healthcare, commerce, and leisure, playing a crucial role in improving the quality of life for those residing in accessible areas (Coyes Chaves et al., 2023)[31]. As a planning strategy centered on transportation and accessibility, Transit-Oriented Development (TOD) is widely recognized as an effective method for achieving sustainable urban development and has been extensively implemented globally. This approach has been applied in various contexts, including comparative studies of the functions of major urban transportation nodes (Su et al., 2021)[32], research on future urban development strategies (Nawaz, Somenahalli, & Allan, 2017)[33], and assessments of urban node value creation (Arliani et al., 2024)[34].

Unlike "Transport" and "Mobility," which primarily express general movement, the term "Travel" has a unique historical background in its modern context. "Travel" originates from the Old French "Travailler," the Latin "Tripalium," and the Middle English "Travail," all of which were initially associated with arduous labor. However, in modern times, "Travel" has evolved to signify movement for purposes such as leisure, exploration, work, or other activities. Consequently, the frequent appearance of "Travel" as a keyword in urban node research reflects a shift in researchers' focus. It indicates that the study of urban nodes has expanded beyond mere transportation functionality to include a diverse range of goals, such as leisure and experiential aspects.

"Travel" emphasizes the study of how urban nodes impact the behavior of tourists and city residents. He and Luo (2020)[35]explored the influence of travel destination nodes on tourist behavior by examining the relationship between travel motivation, satisfaction, and revisit intention among tourists at the Urumqi Silk Road Ski Resort. Their research highlights the importance of understanding tourist motivation from a tourism node perspective to improve ski resort management and increase revisit rates. Similarly, Bardaka and Hersey (2019)[36]investigated the impact of public transportation nodes on the behavior of residents from different income groups. They found that transportation nodes centered around affordable housing require greater accessibility and convenience from public transit compared to those near market-rate housing.In addition, other studies focusing on urban nodes with "Travel" as a keyword include research on the feasibility of green public transportation (Zheng et al., 2020)[37] and the impact of urban transportation node development on individual travel behavior among community residents (Patnala et al., 2023). [38]Overall, whether it is "Accessibility," "Transport," "Mobility," or "Travel," these keywords collectively underscore the critical role that urban nodes play in advancing urban theory development.

Research Objectives: Design and Preservation

In both the high-frequency keywords (Table 2) and the centrality keywords (Table 3), "Design" appears prominently, underscoring its importance in urban studies. "Design" in this context primarily refers to urban design, which includes planning, architecture, landscape, and public space design strategies aimed at optimizing the spatial structure and functional layout of urban areas to enhance environmental quality and residents' quality of life. Urban nodes, as key elements in urban design, have become focal points across multiple research areas. Analysis of existing urban node design research shows that urban node design encompasses various aspects, including urban transport nodes (Gan et al., 2020)[39], urban commercial nodes (Parisi & Donyavi,

2023)[40], urban cultural nodes (Pugalis, 2009)[41], and urban leisure nodes (Chen, 2018)[42]. Well-conceived urban node design can maximize the functionality of these nodes, promoting the efficient operation of different urban zones and improving residents' quality of life. Effective urban node design not only enhances urban transportation and commercial environments but also strengthens the social and cultural vibrancy of cities, thereby driving sustainable urban development.

Additionally, the high-frequency keyword "Land Use" ranks second in Table 2, and although it does not appear in the centrality keywords list, this does not diminish its significance. Research indicates that nearly all studies involving "Land Use" are closely linked to the design of urban transport nodes. Whether it pertains to the siting strategies for public transport nodes or the assessment of residents' satisfaction with node design, "Land Use" remains a critical design factor in urban node development. This underscores its importance as a key design metric in the construction of urban nodes. On the other hand, the keyword "Conservation," which emerged in 2014, did not achieve high frequency but exhibited considerable centrality. Research related to "Conservation" primarily focuses on the protection of urban natural ecosystems (Wang et al., 2022)[43]. Although "Conservation" does not feature prominently among high-frequency keywords, its presence signifies that the objectives of urban node design have evolved beyond mere functionality, with ecological preservation becoming an important criterion in urban node development. Furthermore, since 2017, "Ecosystem Services" has emerged as a new direction in urban node design research. Scholars believe that urban node design is a critical factor influencing high-quality urban development, and "Ecosystem Services" offers an effective approach to balance landscape patterns with urban ecological sustainability. It provides valuable decision-making references for the ecological protection and restoration planning of urban nodes (Liu et al., 2023)[44]. However, research on "Ecosystem Services" is still in its early stages. Current studies mainly explore its role in urban nodes, agricultural landscapes, and park landscapes (Wang et al., 2024)[45], and have yet to deeply expand into the construction of urban nodes centered on "Ecosystem Services." This presents new directions and opportunities for future research in urban node studies.

Research Methods: Networks and Geography

In both the high-frequency keywords table and the centrality keywords table, "Network" and "Geography" are highlighted. The term "Network" is derived from the combination of the words "net" and "work," originally signifying a "mesh" or "web-like structure" in Old English. Since the 16th century, "network" has been used to describe structures composed of interwoven lines, ropes, or other materials, often utilized for capturing or gathering objects. Over time, the meaning of the term has expanded to encompass any system characterized by interconnected nodes. By the late 19th and early 20th centuries, the concept of "network" had become widely applied across various domains, including urban transportation, communications, energy, social interactions, and information technology. Specifically, in this study, the high-frequency term "network" refers to urban networks. Urban networks are typically viewed as multifaceted phenomena where spatial interactions between cities can occur in various forms. These connections encompass multiple dimensions of interaction and exchange, including economic, social, transportation, and informational aspects. Through various activities such as commuting, shopping, and inter-firm trade, these interactions effectively link different urban nodes together (Burger, Van Der Knaap, & Wall, 2014)[46]. Andres and Mekonnen (2012)[47] argue that nodes, links, and network structure are the core elements of urban networks. This is why research on urban nodes often involves discussions of urban networks, as these networks provide the essential framework for

understanding the functions and interactions of urban nodes. Through WOS searches, it is evident that studies on urban nodes frequently address urban networks, underscoring their importance in comprehending the roles and dynamics of urban nodes within the broader urban system.

In recent years, researchers have increasingly focused on areas such as smart cities, cultural cities, and ecological cities. For instance, studies have identified potential ecological networks by constructing ecological corridors in response to land cover changes (Zhang & Song, 2020)[48]. The application of space syntax theory has been utilized to explore the narrative of cultural landscape nodes (Chen & Yang, 2023)[49], while the study of heritage nodes has informed methods for constructing urban cultural networks (Radosavljević et al., 2019)[50]. Additionally, network analysis methods have been employed to identify the construction of smart cultural city nodes (Von Richthofen et al., 2019)[51]. These studies, benefiting from the extensive application of urban network research, provide valuable case studies and methodological support for the study of urban nodes.

Secondly, "Geography" and "Network" hold almost equal importance in the study of urban nodes. Geographical factors can be categorized into broad and narrow levels. Broadly, geographical factors include key functional areas and landmarks where urban nodes are located, with keywords such as "land use," "space," and "areas" being closely related to these factors. From a narrower perspective, researchers focus on how the geographical environment influences the function and spatial layout of urban nodes. As cities expand, new nodes are established in tandem with changes in land use and gradually integrate into existing urban networks. Therefore, studying the relationship between urban expansion and geographical space can reveal the spatial dynamics of the urbanization process. Singh (1999)[52] used GIS (Geographic Information Systems) to map cities, providing a better understanding of urban spatial structures. Carpentieri, Guida, and Chorus (2019))[53] further utilized GIS technology to predict trends in urban economic development. These studies highlight that urban research is inherently tied to geographical considerations. In particular, the study of urban nodes requires a multidimensional spatial analysis approach, encompassing scales from within the city, across urban agglomerations, to regional and global levels, to comprehensively understand the functions and geographical relationships of urban nodes.

Table 2. Distribution of high frequency keywords (top15)

Number	Frequency	Year	High-Frequency Keyword
1	93	1994	City
2	51	2019	Land use
3	49	2013	Accessibility
4	43	1992	Model
5	34	2015	Transport
6	31	2006	Travel
7	30	1996	Design
8	29	2018	Transit Oriented Development
9	29	2015	Impact
10	27	2011	China
11	27	2015	Integration
12	23	2001	Urban
13	23	2017	Ecosystem Services
14	22	2005	Network
15	21	1996	Geography

Table 3. Distribution of high betweenness centrality (BC) keywords(top15)

Number	BC	Year	Keyword
1	0.41	1994	City
2	0.07	2013	Accessibility
3	0.07	1992	Model
4	0.07	2011	China
5	0.07	1996	Geography
6	0.06	1994	Built Environment
7	0.06	2014	Conservation
8	0.05	1996	Design
9	0.05	2001	Urban
10	0.05	2012	Mobility
11	0.05	1999	Space
12	0.04	2005	Network
13	0.04	2018	Areas
14	0.04	2018	Growth
15	0.04	2001	Policy

3.2.2. Keyword Clustering and Timeline Analysis

In CiteSpace, this study employed the Log-Likelihood Ratio (LLR) algorithm to generate a keyword clustering map. The quality of the clustering is evaluated using two key metrics: Modularity (Q value) and Silhouette (S value). Generally, a Q value greater than 0.3 indicates a significant clustering structure, while an S value greater than 0.5 suggests that the clusters are well-structured and reliable, effectively reflecting the thematic structure of the literature (Liu,

Wang, & Zhang, 2017)[54].

This study conducted a keyword clustering analysis on the retrieved literature, with the results indicating a Q value of 0.5497 and an S value of 0.8017, demonstrating a high level of significance and clustering effectiveness within the network, supporting subsequent analyses. To ensure the clarity of the clustering results, only the top 12 significant clustering modules from the map are displayed and ranked in this paper. These modules include "#0 Transit Oriented Development (TOD)," "#1 Globalization," "#2 Ecological Network," "#3 Functions," "#4 Social Network Analysis," "#5 Park Landscape," and "#6 Market," among others (Figure 5).

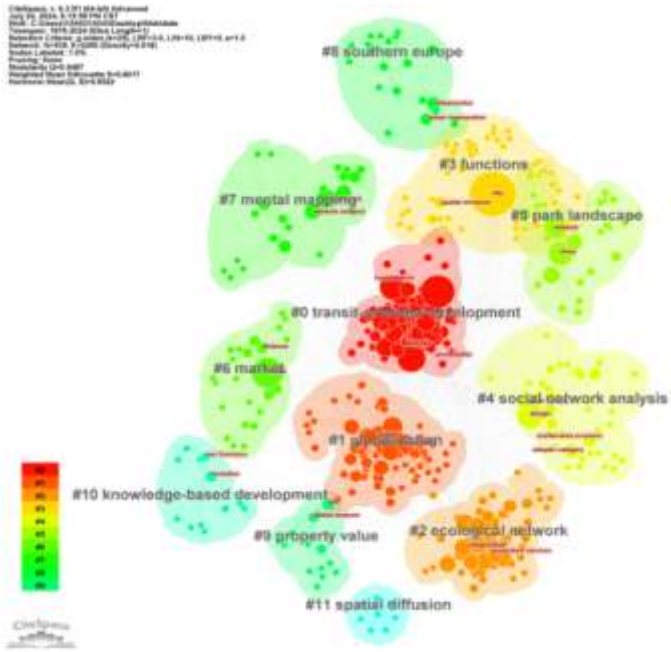


Figure 5. Literature keywords clustering map.

The keyword timeline map is generated based on the keyword co-occurrence map by calculating the frequency of keyword appearances over different periods and arranging them in chronological order to create a visual timeline. This timeline map is used to illustrate the temporal evolution trends of keywords within a specific field. Through this map, researchers can identify the main research hotspots during different periods and track the evolution of these hotspots over time (Ellegaard & Wallin, 2015)[55].

Combining the analysis of the keyword clustering map (Figure 5) and the timeline map (Figure 6), it becomes evident that research on Transit-Oriented Development (TOD) has garnered significant attention from urban researchers since the late 20th century. In the mid-20th century, a notable shift occurred as many American city residents began relocating to suburban areas, leading to the decline of central urban regions, a phenomenon known as counterurbanization. In response to this trend, the U.S. government initiated efforts to revitalize declining urban centers by investing in public transportation infrastructure, thereby facilitating the process of re-urbanization.American architect and planner Peter Calthorpe systematically introduced and promoted the concept of Transit-Oriented Development (TOD) in his 1993 book "*The American Metropolis: Ecology, Community, and the American Dream*". He advocated for a development model focused on public transportation as a solution to unchecked urban sprawl, aiming to foster more sustainable urban growth (Calthorpe, 1993)[56]. The introduction of TOD sparked significant academic discussion and became a prominent topic in urban node research from 2012 to 2022.

The figure indicates that "TOD" (Transit-Oriented Development) and "Globalization" emerged almost simultaneously within the field of urban studies. As globalization progressed, TOD was incorporated into urban development strategies in regions such as Mainland China, Hong Kong, Singapore, and Malaysia. This widespread adoption significantly contributed to the surge of interest in TOD research from 2012 to 2022.

Furthermore, the figure illustrates that from the mid to late 20th century, the construction of "Functions" within urban nodes was a primary focus, particularly in areas with economic significance like "Market" and social value such as "Park Landscape." The discourse surrounding urban "Functions" has persisted as a central theme. Moving into the 21st century, research on "Ecological Networks" began to emerge and became a key topic from 2010 to 2023. Global ecological crises, such as the Gulf of Mexico oil spill and the Fukushima nuclear disaster, alongside the issues of unchecked urban expansion in the context of economic globalization, have led scholars to engage in deeper reflections on urban ecological challenges. This shift has further fueled the ongoing research interest in topics such as "Park Landscape" and "Mental Mapping."

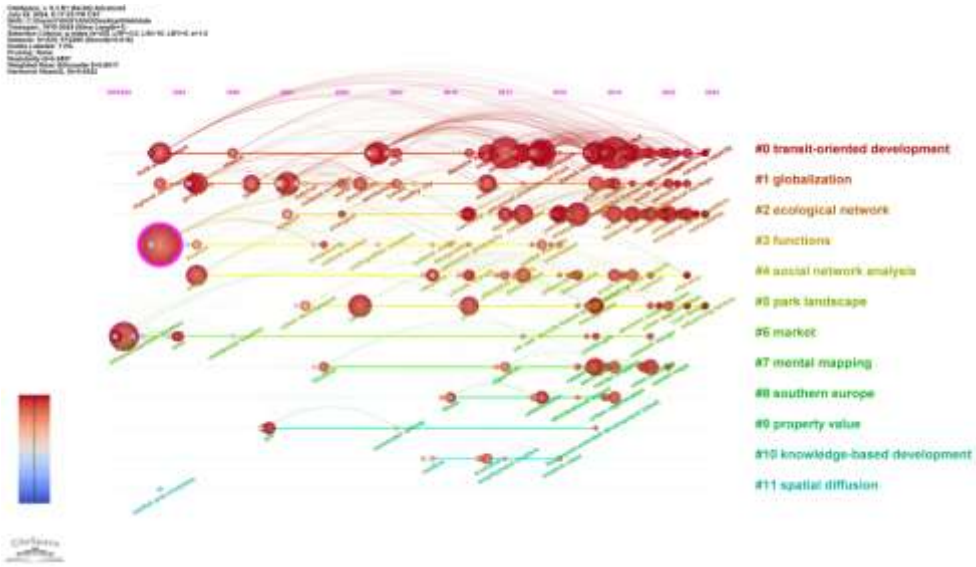
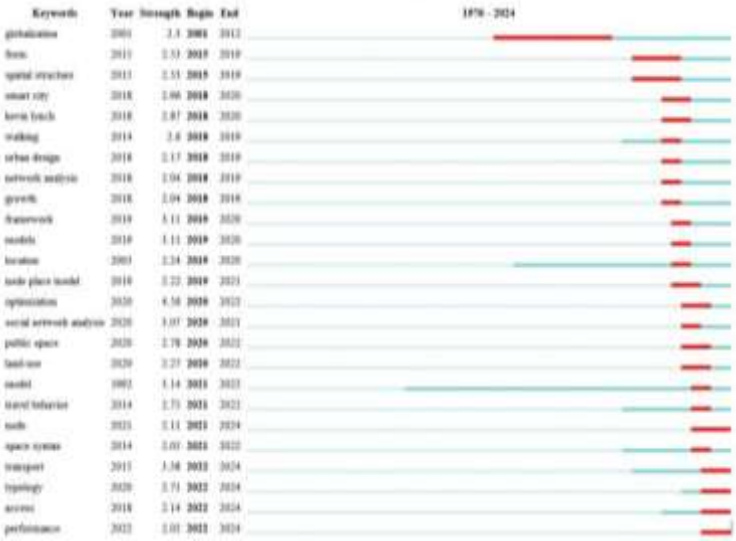


Figure 6. Literature keywords timeline map

3.2.3. Noun Term Burst Detection

Term bursts refer to a significant increase in the frequency of a particular term within a specific time period, indicating that the term or its related research topic has gained notable importance and attention during that time. The burst intensity reflects the academic impact of the term in that period, often representing the research hotspots and scientific development trends of that era (Han & Liang, 2023)[57]. Table 4 presents the keywords with the highest citation bursts across different periods, illustrating the influence and duration of various terms within the field of urban node research. In this table, the blue lines represent the entire study period (1976–2024), while the red lines indicate the duration of the citation bursts. The top 25 keywords with the highest frequency are listed in Table 4.

Table 4. Top 25 high-frequency terms and their burst time.



From 1976 to 2024, research on urban nodes has consistently attracted global attention from scholars. The initial discussions surrounding the concept of nodes originated in the field of control structures and data structures (Lipton, Eisenstat & DeMillo, 1976)[58], after which the concept was gradually applied to various domains such as the ecological structure of landscape corridors (Forman, 1983) [59], urban freight transportation (Ogunsanya, 1984) [60], and the development of green cities (Johnson, 1984)[61].

Entering the 21st century, the acceleration of globalization made "Globalization" a prominent burst keyword in urban node research, persisting for 11 years. The prolonged activity of this keyword reflects the academic community's sustained attention and in-depth exploration of the changes in urban nodes within the context of globalization. Additionally, from 1992 to 2022, research related to "Model" experienced a significant and sustained surge, highlighting the critical role that models play in the study of urban nodes. Particularly in recent years, as urban complexity and diversity have increased, researchers have deepened their understanding of the functions and spatial structures of urban nodes through the development and application of models.For example, in the study by Zhou et al. (2023)[62], social contacts were integrated into the node-place model. Through an empirical analysis of Hong Kong, the study illustrates how refining the model can uncover the complex interactions between urban nodes, social activities, land use, and transportation connectivity. This indicates that models are not merely tools for urban node research but are crucial methods for researchers to understand and optimize urban functions.Thirdly, keywords like "Form" and "Spatial Structure," which are closely related to human perception, have become research focal points. Studies during this period have further revealed the profound impact of urban environments on visual perception, spatial experience, and overall quality of life. For example, Worthington's (2009)[63] research explored the distributed working models within networked cities, highlighting how urban form can promote sustainable development while significantly influencing residents' daily perceptions and interactions. Additionally, Fu, Wang, and Li's (2024)[64] study delved into how the spatial structure of urban agglomerations affects the spatiotemporal evolution of population aging, demonstrating that thoughtful urban design can enhance residents' living experiences and improve urban livability. Researchers have increasingly recognized that optimizing urban form and spatial structure can significantly enhance the perceived quality of the urban environment, thereby improving residents' quality of life and fostering more sustainable and livable urban development. This shift

indicates that urban design is evolving from purely functional planning to a broader focus on environmental experience.

During this process, the theme of "Optimization" exhibited the highest burst intensity, underscoring the necessity of enhancing the functionality and overall quality of urban nodes. This emphasis on optimization highlights its crucial role as a key strategy for achieving sustainable development and ecological restoration, particularly in addressing the challenges posed by complex ecosystems and urban environments (Zhao et al., 2023)[65]. When analyzing the high-burst keywords that have persisted until 2024, "Transport" and "Access" emerge as inseparable and crucial themes in the study of urban nodes. In recent years, with the acceleration of urbanization, researchers have increasingly focused on optimizing transportation systems to enhance the accessibility of urban nodes. This focus reflects a growing recognition of the importance of ensuring efficient and effective connectivity within cities to support their sustainable development and improve the quality of life for urban residents. Kwatra et al. (2023) [66] introduced novel accessibility metrics for transportation networks that significantly enhance the connectivity of urban nodes and substantially improve interactions between cities and their surrounding areas. This optimization of transportation accessibility helps reduce commuting times, alleviate traffic congestion, and ultimately enhance the overall quality of life for residents. Concurrently, the study of urban "Typology" has emerged as an independent research direction, focusing on the classification and comparison of different urban nodes to reveal the typical patterns and characteristics of urban environments.Zandvliet and Dijst (2006)[67] applied spatio-temporal typology methods to analyze the dynamic changes in visitor populations, revealing how nodes are utilized across different temporal and spatial dimensions. Lastly, "Performance" has emerged as a critical indicator for assessing the functionality of urban nodes. By leveraging high-performance simulation and evaluation tools, researchers can precisely quantify the efficiency and effectiveness of urban nodes in their actual operations (Wan et al., 2023)[68].

The analysis of high-impact keywords in urban node research reveals that terms such as "Optimization," "Transport," "Access," "Typology," and "Performance" have become increasingly prominent in recent years. This trend reflects the extensive attention and in-depth exploration by researchers on topics related to the optimization of urban node functions, the enhancement of transportation accessibility, spatial typology analysis, and the evaluation of urban node performance. The sustained prominence of these themes underscores the ongoing research focus on promoting sustainable urban development and addressing the evolving challenges within this field.

4.CONCLUSION

Urban nodes serve as the central pathways and objectives in urban construction and development. The optimization of these nodes to enhance the satisfaction and well-being of both residents and visitors has become a key focus in current urban research. This includes the development of efficient transportation networks to better serve city dwellers, the establishment of economically vibrant commercial centers to attract foot traffic, and the creation of diverse service-oriented recreational communities. These aspects are expected to be crucial focal points in the future development of smart cities, urban tourism districts, and the overall enhancement of social life.

Reflecting on the development trajectory of urban node research, since the introduction of the node concept into urban construction in 1976, this field has gradually matured and expanded over the past four decades. Visual analysis using CiteSpace knowledge maps reveals a significant increase in the number of publications focused on urban nodes beginning in 2009. During this

period, urban construction researchers have not only concentrated on macro-level topics such as urban design, network construction, and geographic information systems but have also increasingly shifted their focus to specific issues such as land use efficiency, urban transportation accessibility, and urban ecology.By 2020, the research on urban nodes entered a phase of rapid development, marked by a significant surge in the number of related publications. The focus of research also shifted from purely functional studies to more human-centered perceptual studies. Concurrently, the scope of research expanded beyond traditional disciplines such as geography, ecology, and urban studies. The integration of psychology, behavioral sciences, and sociology introduced a new level of diversity and complexity to the field, reflecting an interdisciplinary approach to understanding urban nodes.

Analysis of existing studies reveals that Western countries, particularly the United States and the United Kingdom, were the early pioneers in the field of urban node research. Their contributions, characterized by high quality and significant influence, have set the pace for the development of this field. Although China now leads the world in the volume of publications related to urban nodes, its centrality and impact within the research community still require enhancement, and the overall quality of research needs further improvement. Currently, urban node research is primarily focused on three key directions: foundational studies, research objectives, and research methodologies. Specifically, these directions encompass theoretical framework studies centered on transportation and accessibility, urban planning research aimed at design and conservation, and methodological explorations that emphasize the use of geographic information systems and network analysis techniques.

Simultaneously, through the analysis and synthesis of CiteSpace scientific maps, it is evident that there are still significant issues of regional development imbalances and insufficient cross-disciplinary collaboration in global urban node research. Although substantial progress has been made in the quantitative and qualitative analysis of urban nodes, there remains a relative weakness in the practical application of urban node design. This situation provides a stronger theoretical foundation for future practices, driving the optimization and innovation of urban nodes. However, the current research methods on urban nodes are relatively limited, which may lead to an oversimplification of the research process, failing to fully capture the complex dynamics of urban nodes. As global urbanization accelerates and the living standards of city residents improve, researchers are increasingly focusing on the humanistic needs within urban nodes.For example, in the construction of urban leisure nodes, in addition to traditional infrastructure, spiritual services have gradually become the focus. Therefore, as the core approach to urban construction, urban nodes need to be optimized at the spiritual service level to comprehensively improve their overall quality. In terms of research objects, more and more studies have begun to focus on the construction of urban nodes with people as the main body. This not only provides a solid theoretical basis for further optimization and improvement of urban nodes, but also breaks through the limitations of traditional focus on functionality (such as technology and infrastructure). Therefore, how to achieve a balance between meeting spiritual needs and functionality has become one of the key issues to be solved in future research.

In summary, although significant progress has been made in urban node research over the past 40 years, studies on the ecological systems and mental services associated with urban nodes are still in their early stages, indicating substantial growth potential. The issue of regional development imbalance is expected to gradually improve with the advancement of globalization. To drive the comprehensive development of urban node research, future studies will need to integrate various spatial dimensions and disciplinary approaches, emphasizing the importance of

interdisciplinary collaboration. This will foster deeper research and theoretical innovation within the field of urban nodes.

REFERENCES

[1] Montgomery, J. (1998). Making a city: Urbanity, vitality and urban design. *Journal of Urban Design*, 3(1), 93-116.

[2] Ahern, J. (2011). From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. *Landscape and Urban Planning, 100*(4), 341-343.

[3] Lynch, K. (1960). *The image of the city*. MIT Press.

[4] Bertolini, L. (1999). Spatial development patterns and public transport: The application of an analytical model in the Netherlands. *Planning Practice & Research, 14*(2), 199-210.

[5] Surya, B., Ahmad, D. N. A., Sakti, H. H., & Sahban, H. (2020). Land use change, spatial interaction, and sustainable development in the metropolitan urban areas, South Sulawesi Province, Indonesia. *Land, 9*(3), 95.

[6] Yang, X., Zheng, X., Cao, Y., Chen, H., Tang, L., & Yang, H. (2023). Connectivity analysis in pedestrian networks: A case study in Wuhan, China. *Applied Geography, 148*, 102759.

[7] emenza, J. C., & March, T. L. (2009). An urban community-based intervention to advance social interactions. *Environment and Behavior, 41*(3), 323-344.

[8] Della Spina, L. (2019). Multidimensional assessment for "culture-led" and "community-driven" urban regeneration as a driver for triggering economic vitality in urban historic centers.

[9] Gehl, J. (2010). *Cities for people*. Island Press.

[10] Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of business research*, *133*, 285-296.

[11] Jia B, Chen Y, Wu J. 2021.Bibliometric Analysis and Research Trend Forecast of Healthy Urban Planning for 40 Years (1981–2020). *International Journal of Environmental Research and Public Health*. ; 18(18):9444.

[12] Freeman, L. C. (1979). Centrality in social networks: Conceptual clarification. *Social Networks, 1*(3), 215–239.

[13] Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology, 57*(3), 359-377.

[14] Vale, D. S. (2015). Transit-oriented development, integration of land use and transport, and pedestrian accessibility: Combining node-place model with pedestrian shed ratio to evaluate and classify station areas in Lisbon. *Journal of transport geography*, *45*, 70-80.

[15] Button, K. (2002). City management and urban environmental indicators. *Ecological economics*, *40*(2), 217-233.

[16] Cicirelli, F., Guerrieri, A., Spezzano, G., & Vinci, A. (2017). An edge-based platform for dynamic smart city applications. *Future Generation Computer Systems*, *76*, 106-118.

[17] Pugalis, L. (2009). The culture and economics of urban public space design: Public and professional perceptions. *Urban Design International*, *14*, 215-230.

[18] Lu, Y., Huang, D., Liu, Y., Zhang, Y., Jing, Y., Chen, H., ... & Liu, Y. (2024). Exploring the optimization and management methods of ecological networks based on the cluster mode: A case study of Wuhan Metropolis, China. *Land Use Policy*, *137*, 107021.

[19] Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for information Science and Technology*, *62*(7), 1382-1402.

[20] Rahman, M. H., Ashik, F. R., & Mouli, M. J. (2022). Investigating spatial accessibility to urban facility outcome of transit-oriented development in Dhaka. *Transportation Research Interdisciplinary Perspectives*, *14*, 100607.

[21] Lu, M., Zhang, Y., Liang, F., & Wu, Y. (2022). Spatial relationship between land use patterns and ecosystem services value—Case study of Nanjing. *Land*, *11*(8), 1168.

[22] Nigro, A., Bertolini, L., & Moccia, F. D. (2019). Land use and public transport integration in small cities and towns: Assessment methodology and application. *Journal of Transport Geography*, *74*, 110-124.

[23] Yun, L. M., Zhi, T. X., Hassan, A. S., Witchayangkoon, B., & Nasir, M. H. A. (2019). A study on Kevin Lynch's urban design elements at Bayan Baru Township, Penang. *International Transaction Journal of Engineering, Management,*

and Applied Sciences and Technologies, *10*(19), 1-20.

[24] Debrezion, G., Pels, E., & Rietveld, P. (2007). The impact of railway stations on residential and commercial property value: A meta-analysis. *The journal of real estate finance and economics*, *35*, 161-180.

[25] Czarnecki, B., & Chodorowski, M. P. (2021). Urban environment during post-war reconstruction: Architectural dominants and nodal points as measures of changes in an urban landscape. *Land*, *10*(10), 1083.

[26] Lahoorpoor, B., & Levinson, D. M. (2020). Catchment if you can: The effect of station entrance and exit locations on accessibility. *Journal of Transport Geography*, *82*, 102556.

[27] Jabbari, M., Fonseca, F., & Ramos, R. (2021). Accessibility and connectivity criteria for assessing walkability: an application in Qazvin, Iran. *Sustainability*, *13*(7), 3648.

[28] COYES CHAVES, D. A. N. I. E. L., JARAMILLO MOLINA, C. I. R. O., & ARANGO PASTRANA, C. A. (2023). Evaluation of spatial accessibility levels through infrastructure based models. case study, department of Nariño, Colombia. *Perspectiva Geográfica*, *28*(2), 1.

[29] Ahmed, S., Muhammad, I. B., Abdulraman, M. E., & Adebisi, G. O. (2022). Visual accessibility and inclusive wayfinding design in hospital environment in Nigeria.

[30] Papa, E., & Bertolini, L. (2015). Accessibility and transit-oriented development in European metropolitan areas. *Journal of Transport Geography*, *47*, 70-83.

[31] COYES CHAVES, D. A. N. I. E. L., JARAMILLO MOLINA, C. I. R. O., & ARANGO PASTRANA, C. A. (2023). Evaluation of spatial accessibility levels through infrastructure based models. case study, department of Nariño, Colombia. *Perspectiva Geográfica*, *28*(2), 1.

[32] Su, S., Zhang, H., Wang, M., Weng, M., & Kang, M. (2021). Transit-oriented development (TOD) typologies around metro station areas in urban China: A comparative analysis of five typical megacities for planning implications. *Journal of transport geography*, *90*, 102939.

[33] Nawaz, M., Somenahalli, S., & Allan, A. (2017). Bus-based transit-oriented development (BTOD): Opportunities and challenges for low-density, car-dependent Australian cities. *Road & Transport Research: A Journal of Australian and New Zealand Research and Practice*, *26*(2), 62-74.

[34] Arliani, V., Sjafruddin, A., Santoso, I., & Winarso, H. (2024). Impact of internal accessibility on value creation in transit oriented development (TOD) area. *Transportation Research Interdisciplinary Perspectives*, *25*, 101106.

[35] He, X., & Luo, J. M. (2020). Relationship among travel motivation, satisfaction and revisit intention of skiers: A case study on the tourists of urumqi silk road ski resort. *Administrative Sciences*, *10*(3), 56.

[36] Bardaka, E., & Hersey, J. (2019). Comparing the travel behavior of affordable and market-rate housing residents in the transit-rich neighborhoods of Denver, CO. *Travel Behaviour and Society*, *15*, 74-87.

[37] Zheng, J., Cheng, Y., Ma, G., Han, X., & Yu, L. (2020). Feasibility analysis of green travel in public transportation: A case study of Wuhan. *Sustainability*, *12*(16), 6531.

[38] Patnala, P. K., Parida, M., & Chalumuri, R. S. (2023). Gender differentials in travel behavior among TOD neighborhoods: Contributions of built environment and residential self-selection. *Travel Behaviour and Society*, *31*, 333-348.

[39] Gan, M., Li, X., Zhang, F., & He, Z. (2020). Regional Logistics Network Design in Mitigating Truck Flow-Caused Congestion Problems. *Journal of Advanced Transportation*, *2020*(1), 5197025.

[40] Parisi, L., & Donyavi, S. (2023). The hubs of transformation dictated by the innovation wave: Boston as a case study. *Journal of Regional and City Planning*, *34*(3), 248-269.

[41] Pugalis, L. (2009). The culture and economics of urban public space design: Public and professional perceptions. *Urban Design International*, *14*, 215-230.

[42] Chen, C. (2018). Designing the danceable city: how residents in Beijing cultivate health and community ties through urban dance. *Journal of the American Planning Association*, *84*(3-4), 237-249.

[43] Wang, Y., Liao, J., He, Y., & Chen, P. (2022). Evolution and ecological implications of land development and conservation patterns on the Qinghai-Tibet Plateau. *Land*, *11*(10), 1797.

[44] Liu, X., Su, Y., Li, Z., & Zhang, S. (2023). Constructing ecological security patterns based on ecosystem services trade-offs and ecological sensitivity: A case study of Shenzhen metropolitan area, China. *Ecological Indicators*, *154*, 110626.

[45] Wang, Y., Pan, Y., Meng, X., Zhu, M., Lin, L., & Ding, Z. (2024). Exploring recreational ecosystem services and influencing factors in megaparks using mobile phone data—Evidence from the Yangtze River Delta region. *Ecological Indicators*, *165*, 112195.

[46] Burger, M. J., Van Der Knaap, B., & Wall, R. S. (2014). Polycentricity and the multiplexity of urban networks. *European Planning Studies*, *22*(4), 816-840.

[47] Andres, S., & Michael, M. (2012). Urban network analysis—a new toolbox for arcgis. *Revue internationale de géomatique*, *22*(2), 287-305.

[48] Zhang, Y., & Song, W. (2020). Identify ecological corridors and build potential ecological networks in response to recent land cover changes in Xinjiang, China. *Sustainability*, *12*(21), 8960.

[49] Chen, H., & Yang, L. (2023). Analysis of narrative space in the chinese classical garden based on narratology and space syntax—taking the humble administrator's garden as an example. *Sustainability*, *15*(16), 12232.

[50] Radosavljević, U., Đorđević, A., Lalović, K., Živković, J., & Đukanović, Z. (2019). Nodes and networks: The generative role of cultural heritage for urban revival in Kikinda. *Sustainability*, *11*(9), 2509.

[51] Von Richthofen, A., Tomarchio, L., & Costa, A. (2019). Identifying communities within the smart-cultural city of Singapore: A Network Analysis Approach. *Smart Cities*, *2*(1), 66-81.

[52] Singh, R. R. (1999). Sketching the city: a GIS-based approach. *Environment and Planning B: Planning and Design*, *26*(3), 455-468.

[53] Carpentieri, G., Guida, C., & Chorus, P. (2019). Land-Use and Transport integration polices and real estate values. The development of a GIS methodology and the application to Naples (Italy). *TeMA-Journal of Land Use, Mobility and Environment*, *12*(3), 313-330.

[54] Liu, Z., Wang, Y., & Zhang, X. (2017). Evaluating and visualizing the evolution of social network research from 1998 to 2016 using CiteSpace. *Journal of Informetrics, 11*(3), 763-775.

[55] Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics, 105*(3), 1809-1831.

[56] Calthorpe, P. (1993). *The next American metropolis: ecology, community, and the American dream*. New York: Princeton Architectural Press.

[57] Han, Y., & Liang, Y. (2023). Scientific Knowledge Map Study of Therapeutic Landscapes and Community Open Spaces: Visual Analysis with CiteSpace. *Sustainability*, *15*(20), 15066.

[58] Lipton, R. J., Eisenstat, S. C., & DeMillo, R. A. (1976). Space and time hierarchies for classes of control structures and data structures. *Journal of the ACM (JACM)*, *23*(4), 720-732.

[59] FORMAN, R. T. (1983). Corridors in a landscape-their ecological structure and function. *Ekologia Csfr*, *2*(4), 375-387.

[60] Ogunsanya, A. A. (1984). Urban markets as freight nodes in the Lagos Metropolis. *Habitat International*, *8*(3-4), 173-179.

[61] Johnson, R. (1984). The'Green City'Concept: proposals for Auckland NZ. *Town Planning Review*, *55*(3), 290.

[62] Zhou, M., Zhou, J., Zhou, J., Lei, S., & Zhao, Z. (2023). Introducing social contacts into the node-place model: A case study of Hong Kong. *Journal of Transport Geography*, *107*, 103532.

[63] Worthington, J. (2009). Urban form for a sustainable future: how sustainable is distributed working in the networked city?. *Journal of Green Building*, *4*(4), 148-157.

[64] Fu, M., Wang, L., & Li, Q. (2024). How Does the Spatial Structure of Urban Agglomerations Affect the Spatiotemporal Evolution of Population Aging?. *Sustainability*, *16*(9), 3710.

[65] Zhao, J., Yu, Q., Xu, C., Ma, J., Liu, W., Sun, W., ... & Nawaz, T. (2023). Integrated approach for ecological restoration and ecological spatial network optimization with multiple ecosystem functions in mining areas. *Ecological*

Indicators, *156*, 111141.

[66] Kwatra, D., Rao, K. R., & Bhatnagar, V. (2023). Novel accessibility metrics based on hierarchical decomposition of transport networks. *Zeszyty Naukowe. Transport/Politechnika Śląska*, (118).

[67] Zandvliet, R., & Dijst, M. (2006). Short-term dynamics in the use of places: A space-time typology of visitor populations in the Netherlands. *Urban Studies*, *43*(7), 1159-1176.

[68] Wan, L., Yin, G., Wang, J., Ben-Dor, G., Ogulenko, A., & Huang, Z. (2023). PATRIC: A high performance parallel urban transport simulation framework based on traffic clustering. *Simulation modelling practice and theory*, *126*, 102775.